LOCATING ASSEMBLY HAVING AN EXTENDABLE CLAMPING FINGER

RELATED APPLICATIONS

[0001] This patent application claims priority to and all advantages of United States Provisional Patent Application No. 60/394,841, which was filed on July 10, 2002.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The subject invention generally relates to locating pins for inserting into a work piece to position and hold the work piece. More specifically, the subject invention relates to a locating pin having an extendable finger or fingers for holding the work piece in place and for retracting into the locating pin to allow the work piece to be removed from the locating pin.

2. Description of the Prior Art

[0003] Various locating assemblies are known to those skilled in the art which employ a locating pin to precisely position a work piece. These locating assemblies include an extendable clamping arm, or finger, to hold the work piece in place, as illustrated in United States Patent No. 6,378,855 to Sawdon et al.

[0004] The '855 patent to Sawdon et al discloses a locating assembly having a housing and a locating pin. A steel shaft inside the housing has a pair of hooks. The pair of hooks are extendable from the locating pin through a pair of vertical slots. A first dowel passes through a slot of the steel shaft and is attached to the housing. A second dowel runs through a bottom of the steel shaft. A pneumatic piston has a slot for receiving the second dowel and for controlling the steel shaft as the pneumatic

piston is moved.

[0005] A clamping cycle begins when the pneumatic piston is moved in a horizontal direction, guiding the second dowel through the slot in the pneumatic piston and moving the steel shaft. As the steel shaft moves, the slot in the steel shaft moves along the first dowel, thus guiding the shaft. The first and second slots are shaped such that as the pneumatic piston is moved, the steel shaft is forced out of the locating pin and pulled in a downward vertical direction to hold the work piece with the hooks.

[0006] The locating assembly disclosed in the '855 patent, among other similar locating assemblies of the prior art, is expensive and difficult to maintain. For instance, the hook disclosed in the '855 patent, while being subjected to forces in many directions, is prone to failure due to fatigue. Furthermore, the hooks are limited to a single path of motion, depending on a shape of the first and second slots, and thus cannot be adjusted. This may result in too great of a clamping force being applied to the work piece, causing denting, or conversely, too little clamping force, allowing the work piece to move while being worked on. When using multiple clamping devices, clamping forces at each device may vary, resulting in clamping that is not uniform, damage to the work piece, or movement of the work piece while being worked on. The locating assemblies of the prior art also require extra time to both extend out of the locating pin and then clamp down on the work piece. The extra time cuts down on production speeds and reduces efficiency.

[0007] Thus, it would be advantageous to provide a locating assembly that may be adjusted to provide an ideal clamping force on work pieces of various thickness. It would also be advantageous to provide a locating assembly having extendable fingers that are

less susceptible to failure to eliminate aspects of existing locating assemblies that require extensive maintenance, thus streamlining manufacturing operations. It would also be advantageous to provide a locating assembly capable of working faster, more efficiently, more precisely, and more uniformly by extending and retracting at least one finger from the locating pin simultaneous with a downward movement of the locating pin. It would also be advantageous for these extendable fingers to have minimal gaps around them so that no foreign materials or contamination enters and destroys the internal mechanism.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0008] The subject invention provides a locating assembly including a body. The body defines an internal cavity and an opening from the cavity to the exterior of the body. A locating pin is disposed in the cavity. The locating pin extends along an axis out of the opening to a distal end. An actuator moves the locating pin rectilinearly along the axis into and out of the opening. At least one finger is supported by the locating pin adjacent to the distal end. The finger moves radially into and out of the locating pin, transversely to the axis of the locating pin. A mechanism rotates in response to the rectilinear movement of the locating pin for moving the finger radially.

[0009] The locating assembly, through the mechanism, precisely controls the finger so that the locating assembly works faster, more efficiently, more precisely, and more uniformly by extending and retracting the finger through the locating pin simultaneous with the rectilinear movement of the locating pin. Furthermore, the locating assembly does not require extensive maintenance, thus making manufacturing operations more efficient. The locating assembly is also self compensating to provide an ideal clamping

force on work pieces of various size. Thus, when multiple locating assemblies are used, each assembly is self compensating to provide a uniform clamping force on the work piece.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0011] Figure 1A is a perspective view of the locating assembly;

[0012] Figure 1B is a perspective view of a work piece with the locating pins in the "clamped" position;

[0013] Figure 2A is a cross-sectional side view of the locating assembly;

[0014] Figure 2B is an enlarged fragmentary view of a portion of Figure 2A showing the cam follower including the cam pin extending into the cam slot;

[0015] Figure 3 is a side view of the locating assembly taken along line 3-3 and from the right side of Figure 2A;

[0016] Figure 4 is a rear view of the locating assembly taken along line 4-4 and from the right side of Figure 3;

[0017] Figure 5A is a fragmentary cross-sectional view of the locating assembly including the locating pin in an "unclamped" position and having fingers retracted inside the locating pin;

[0018] Figure 5B is a fragmentary cross-sectional view like Figure 5A but showing the locating pin in the "clamped" position and having the fingers extended from the locating pin;

[0019] Figure 6A is a sectional top view of the locating assembly taken along line 6A-6A of Figure 5A showing the fingers retracted inside the locating pin;

[0020] Figure 6B is a sectional top view of the locating assembly taken along line 6B-6B of Figure 5B showing the fingers extended from the locating pin;

[0021] Figure 7 is a fragmentary exploded view of the fingers, dowels, and the central post;

[0022] Figure 8 is a perspective view of the locating pin including the pin mount;

[0023] Figure 9 is a perspective view of the top of the central post showing the dowels and defining the cam slot;

[0024] Figure 10 is a perspective view of the bottom of the central post showing the cam slot;

[0025] Figure 11 is a perspective view of the body;

[0026] Figure 12 is a perspective view of the piston; and

[0027] Figure 13 is a perspective view of the coupler plate.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0028] Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a locating assembly is generally shown at **10** in Figure 1A. The locating assembly **10** includes a locating pin **12** that, as shown in Figure 1B, positions and holds a work piece **14** so that work can be performed on the work piece **14**.

For example, the work piece **14** may be traveling on an assembly line to various stations, where work is performed on the work piece **14**. The locating pin **12** precisely positions and holds the work piece **14** so that a person or machine performing the work may do so without the work piece **14** moving out of place. Preferably, the locating assembly **10** is located at the station. Upon arrival at the station, the work piece **14**, which preferably defines a locating hole for receiving the locating pin **12**, is placed on the locating assembly **10**. The locating assembly **10** holds the work piece **14** with the locating pin **12** through the locating hole. Alternatively, the locating assembly **10** may hold the work piece **14** with the locating pin **12** along an edge of the work piece **14**. After completion of the work, the locating assembly **10** releases the work piece **14**. Alternatively, the locating assembly **10** may move with the assembly line to accompany the work piece **14** as the work piece **14** travels to the various stations. In the alternative scenario, the locating assembly **10** holds the work piece **14** at a beginning of the assembly line and releases the work piece **14** at an end of the assembly line. It is to be appreciated that the locating assembly **10** may be used independent of an assembly line for a variety of purposes.

[0029] The locating assembly **10** includes a body **16** for housing components of the locating assembly **10**. As shown in Figure 11, the body **16** defines an internal cavity **18** and an opening **20** from the cavity **18** to the exterior of the body **16**. Preferably, the body **16** further defines a second opening **22** from the cavity **18** to the exterior of the body **16**. The second opening **22** is opposite the first opening **20**. Preferably, the body **16** is box shaped, but may be cylindrical, etc. The body **16** may also define a plurality of auxiliary openings **24** transverse to the cavity **18**. The auxiliary openings **24** allow optional

instruments and tools, such as a part stripper (not shown), part sensor (not shown), mounting brackets (not shown) to be attached to the body **16**. Additional auxiliary openings **24** may be included on another surface opposite the auxiliary openings **24** and adjacent the openings **20**, **22**. A pair of cam holes **26** are defined in the body **16** transverse to and in communication with the cavity **18** for reasons to be discussed below. Preferably, the cam holes **26** are defined opposite each other in the body **16**.

[0030] Referring to Figures 2A, 3 and 4, the locating pin **12** is disposed in the cavity **18** and extends along an axis **A** out of the opening **20** to a distal end **28**. The locating pin **12** includes a cylindrical portion **30** adjacent to the body **16** and a bullet-shaped portion **32** opposite the body **16**. The bullet-shaped portion **32** centers the work piece **14** on the locating pin **12**. More specifically, the bullet-shaped portion **32** centers the locating hole in the work piece **14** to position the work piece **14** in preparation for work to be performed on the work piece **14**.

[0031] The locating pin **12**, shown in more detail in Figure 8, also includes a pin mount **34**. The pin mount **34**, among other purposes to be described below, holds the locating pin **12** to the piston **54** and prevents the locating pin **12** from being removed from the cavity **18** by abutting the body cap **36** about the opening **20**. Preferably, as shown in Figure 2A, a body cap **36** is mounted to the body **16**. The body cap **36** is coaxial with the opening **20** and defines a corresponding opening **38** smaller in width than the opening **20**. Thus, the body cap **36** provides an annular ledge **40** overlapping the opening **20**. The locating pin **12** extends out of the opening **20** and through the corresponding opening **38** in the body cap **36**. The pin mount **34** abuts the body cap **36** at the annular ledge **40** to retain the locating pin **12** in the cavity **18**.

[0032] Preferably, as shown in Figures 1A, 2A, 3, and 4, an annular ring **42** is disposed about the locating pin **12** and mounted to the body cap **36**. More specifically, the annular ring **42** is mounted to the body cap **36** opposite to the body **16** and coaxial with the openings **20**, **38**. Preferably, fasteners **44** connect the body cap **36** to the body **16**. The fasteners **44** include D-shaped washers **46** that overlap the annular ring **42** to hold the annular ring **42** onto the body cap **36**. The annular ring **42** abuts a surface **48** of the work piece **14** about the locating pin **12**. The annular ring **42** may be removed, remachined, and replaced with another annular ring **42** to accommodate work pieces **14** of various thickness and contour. To remove the annular ring **42**, the fasteners **44** are loosened and the D-shaped washers **46** are rotated to bring a flat portion **50** of the washers **46** adjacent to the annular ring **42** such that the washers **46** no longer overlap the annular ring **42**. The annular ring **42** is removed and reworked or replaced with another annular ring **42** and is placed back on the locating assembly **10**, and the washers **46** are rotated back to overlap the other annular ring **42**. Through replacement of the annular ring **42**, the locating assembly **10** is adjustable to provide, in combination with components described below, an ideal clamping force on work pieces **14** of various thickness and contour. Thus, when multiple locating assemblies **10** are used to hold the work piece **14**, each assembly **10** may be adjusted to provide a uniform clamping force on the work piece **14**.

[0033] An actuator **52**, shown schematically throughout the figures, is mounted to the body **16** at the second opening **22**. Preferably, an actuator mounting plate **53** is disposed between the body and the actuator for mounting the actuator to the body. The mounting plate **53** also acts as an electrical insulator to protect the actuator **52**. The actuator mounting plate **53** is coaxial with the second opening **22** and defines a second

corresponding opening **55** smaller in width than the second opening **22**. The actuator **52** is connected to the locating pin **12** through the pin mount **34** for rectilinearly moving the locating pin **12** along the axis **A**. More specifically, a piston **54** is disposed in the cavity **18**. The piston **54** is connected to the pin mount **34** opposite the locating pin **12**. A coupler plate **56** is also disposed in the cavity **18** and is connected to the piston **54** opposite the pin mount **34**. The coupler plate **56** also acts as an electrical insulator to protect the actuator **52**. A coupler **58** is connected to the actuator **52** through the second opening **22** and the second corresponding opening **55** and extends into the cavity **18**. The coupler **58** is connected to the coupler plate **56** opposite the actuator **52**. As shown in Figure 13, the coupler plate **56** defines a key slot **57** for receiving the coupler **58**. Referring again to Figures 1A, 2A, 3, and 4, the coupler **58** is free-floating in the key slot **57**. The key slot **57** aids in maintenance of the locating assembly by allowing the coupler **58** to be removed from the key slot **57**, allowing the actuator **52** to be removed from the locating assembly **10**. The locating pin **12**, piston **54**, coupler plate **56**, and coupler **58** move rectilinearly along the axis **A** in response to the rectilinear movement provided by the actuator **52**. The rectilinear movement of the actuator **52** provides a clamping force through the locating pin **12** and onto the work piece **14** to hold the work piece **14** on the locating assembly **10**.

[0034] A pair of fingers **60** are supported by the locating pin **12** adjacent the distal end **28**. The two fingers **60** are disposed on opposite sides of the axis **A**. By supporting the fingers **60** with the locating pin **12**, the fingers **60** are fatigue resistant and require little maintenance, thus streamlining manufacturing operations. Preferably, the fingers **60** are supported by the cylindrical portion **30** proximal to the bullet-shaped portion **32** for

spacing the fingers **60** from the body **16**. The fingers **60** are disposed in the cylindrical portion **30** because of space considerations within the locating pin **12**, thus providing a minimal gap all around the fingers **60**. Preferably, the fingers **60** are also disposed as close to the bullet-shaped portion **32** as possible to allow a maximum distance between the body **16** and the fingers **60**. The maximum distance between the fingers **60** and the body **16** allows the locating assembly **10** to accommodate a greater range of work pieces **14** having various thicknesses than if the fingers **60** were positioned closer to the body **16**.

[0035] Referring to Figure 7, the fingers **60** each include a slot **64**. The slots **64** extends across the radial path of movement of the fingers **60**, respectively. As shown in Figure 7, the cylindrical portion **30** of the locating pin **12** defines perforations **67**. The fingers **60** are movable radially into and out of the locating pin **12** through the perforations **67**, transversely to the axis **A** of the locating pin **12**. As shown in Figures 5A and 6A, the fingers **60** are completely retractable into the locating pin **12** so that a maximum diameter $\mathbf{d_1}$ of the locating pin **12** and the fingers **60** is equal to a diameter of the locating pin **12**. Thus, the work piece **14** may be centered on and removed from the locating pin **12** without catching on the fingers **60**.

[0036] During operation, as shown in Figure 5B and 6B, the fingers **60** are moved radially out of the locating pin **12** such that a combined diameter $\mathbf{d_2}$ of the extended fingers **60** is greater than the diameter $\mathbf{d_1}$ of the locating pin **12**. The fingers **60** contact the work piece **14** as the locating pin **12** is moved rectilinearly toward the work piece **14**. The actuator **52** provides the clamping force of the fingers **60** on the work piece **14** through the rectilinear movement of the locating pin **12**. The work piece **14** is held

between the fingers **60** and the annular ring **42**. The locating assembly **10**, by combining the radial movement of the fingers **60** through the locating pin **12** simultaneously with the rectilinear movement of the locating pin **12**, works fast, efficiently, precisely, and uniformly to hold the work piece **14**. A mechanism **68**, to be described in detail below, rotates in response to the rectilinear movement of the locating pin **12** to move the fingers **60** radially.

[0037] The mechanism **68** includes a central post **70** disposed between the actuator **52** at a first end **72** and the fingers **60** at a second end **74**. More specifically, the central post **70** is disposed between the coupler plate **56** at the first end **72** and the fingers **60** at the second end **74**. The central post **70** rests on a surface **76** of the coupler plate **56**, which rectilinearly moves the central post **70** in response to the rectilinear movement of the actuator **52**. The central post **70** rotates in response to the rectilinear movement. The surface **76** of the coupler plate **56** in contact with the central post **70** functions as a thrust bearing to facilitate the rotational movement of the central post **70**. The central post **70** extends through and is independent from the piston **54** for separating the rotational movement of the central post **70** from the rectilinear movement of the locating pin **12**. The central post **70** includes a top portion **78** and a bottom portion **80**. The bottom portion **80** has a greater diameter than the top portion **78** to present a ledge **82**. The ledge **82** abuts the pin mount **34**. Thus, as the actuator **52** rectilinearly moves the locating pin **12** toward the body cap **36**, the pin mount **34** contacts the ledge **82** to move the central post **70** rectilinearly with the locating pin **12**. As the actuator **52** moves the locating pin **12** rectilinearly away from the body **16**, the coupler plate **56** moves the central post **70** along with the piston **54**.

[0038] A motion converter **84** converts the rotational movement of the central post **70** into radial movement of the fingers **60**. As shown in Figure 7, the converter **84** includes the slots **64** in each of the fingers **60** and dowels **86** extending axially from the second end **74** of the central post **70** and into each of the slots **64**, respectively. The dowels **86** are offset from the axis **A** for radially moving the fingers **60** in response to rotational movement of the central post **70**. It is to be understood that only one finger **60** is necessary, wherein only one dowel **86** extends into the slot **64** to radially move the finger **60**.

[0039] The rotational movement of the central post **70** moves the dowels **86** along an arcuate path. As the dowels **86** move through the respective slots **64**, which are straight, the dowels **86** forces the fingers **60** to move radially to maintain the slots **64** in alignment with the dowels **86**. For example, as shown in Figures 6A and 6B, the dowels **86** begin at an end of the respective slots **64**. The dowels **86** move along the arcuate path toward the middle of the slots **64** and move the fingers **60** radially away from the axis **A** to maintain the slots **64** in alignment with the dowels **86**.

[0040] Referring to Figure 2B, a pair of cams **90** and corresponding cam followers **92** interconnect the central post **70** and the body **16** for rotating the central post **70** in response to the rectilinear movement of the locating pin **12**. The pair of cams **90** and the corresponding cam followers **92** are disposed on opposite sides of the axis **A**. The pair of cams **90** and corresponding cam followers **92** stabilize the central post **70** to allow the central post **70** to rotate smoothly within the cavity **18**. Preferably, the cams **90** are disposed in the central post **70** and the cam followers **92** are mounted to the body **16**. As best shown in Figures 9 and **10**, the cams **90** are defined by cam slots **94**. The cam slots

94 are defined in first portions **96** beginning proximal to the first end **72** of the central post **70**. The first portions **96** extend around the central post **70** toward the second end **74**. Preferably, the first portions **96** have a helical shape. The cam slots **94** are further defined in second portions **98** continuing from the first portions **96**. The second portions **98** are distal to the first end **72** and extend axially straight toward the second end **74**.

[0041] The cam followers **92** comprise cam pins **100**, which are slidably disposed in the respective cam slots **94**. Preferably, the cam followers **92** are mounted to the body **16** and the cam pins **100** are inserted into the cavity **18** through the respective cam holes **26**. As shown best in Figure 12, the piston **54** defines piston cam slots **27**. The piston cam slots **27** allow the cam pins **100** to extend into the cavity **18** without affecting the rectilinear movement of the piston **54**. The cam pins **100** extend into the respective cam slots **94** and guide the central post **70** as the central post **70** moves rectilinearly, as further described below.

[0042] During operation, the cam pins **100** begin at an end of the first portions **96** distal to the second portions **98**. As the actuator **52** rectilinearly moves the locating pin **12** downward along the axis **A**, as shown in Figure 5B, the first portions **96** move along the cam pins **100**, respectively, and rotate the central post **70** to extend the fingers **60** out of the locating pin **12**. The helical shape of the first portions **96** facilitates smooth movement of the cam pins **100** through the first portions **96**. The cam slots **94** continue to move along the cam pins **100**, respectively, from the first portions **96** to the second portions **98**. The second portions **98** move along the cam pins **100** and maintain the central post **70** in position, with the fingers **60** extended, while the central post **70** continues to rectilinearly move along the axis **A** with the locating pin **12** to provide the

clamping force on the work piece **14**.

[0043] Preferably, a switch **110** is mounted to the body **16** for detecting a position of the locating pin **12**. The switch **110** includes a switch housing **112** that contains various components of the switch **110**. An upper sensor **114** is maintained in a constant position within the switch housing **112**. Tripping of the upper sensor **114** indicates that the locating pin **12** is in an "up" position, with the fingers **60** retracted inside the locating pin **12**. The switch **110** further includes a trip screw **116** that is mounted to the coupler plate **56**. The body **16** defines a switch slot **118**. The trip screw **116** extends through the switch slot **118** and into the switch housing **112**. More specifically, the trip screw **116** is mounted to the coupler plate **56** for tripping the upper sensor **114**. An adjustment mechanism **120** allows the switch **110** to be calibrated. The adjustment mechanism **120** includes an adjustable plate **122** that contains a lower sensor **124**. To calibrate the switch **110**, the work piece **14** is placed on the locating assembly **10**. The locating pin **12** is rectilinearly moved toward the work piece **14** to extend the fingers **60**. The fingers **60** are brought into contact with the work piece **14**. The adjustable plate **122** is adjusted such that the lower sensor **124** is tripped by the trip screw **116** when the fingers **60** are in contact with the work piece **14**, indicating a "clamped" position. Thus, the switch **110** indicates when the locating pin **12** is in the up or clamped position depending on the position of the trip screw **116**. The up or clamped position indication, among other uses, is particularly useful on an assembly line to prevent a separate machine from performing work on the work piece **14** without an indication of the locating pin **12** in the clamped position.

[0044] Obviously, many modifications and variations of the present invention are

possible in light of the above teachings. The invention may be practiced otherwise than as specifically described within the scope of the appended claims. In addition, the reference numerals in the claims are merely for convenience and are not to be read in any way as limiting.

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